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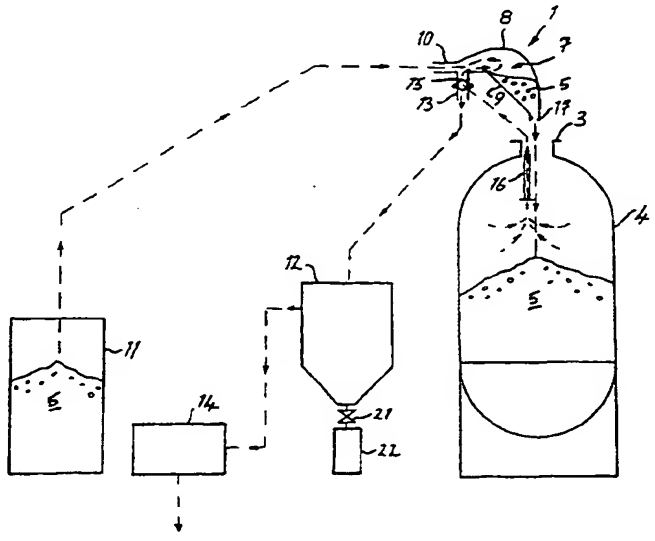

(57) Abstract

The vessel is charged using a vacuum separator unit (1) positioned above the top of the reactor vessel (4). The vacuum separator unit induces flow of a transport gas along a flow path from a store (11) of particulate material (5) from which the particulate material is drawn. The vacuum separator unit (1) separates the transport gas from the particulate material as the gas is forced to reverse direction in a chamber (7), reducing the velocity of the transport gas causing the particulate material (5) to be deposited in the separator unit (1). The particulate material is discharged into the reactor vessel (4) via an unloading outlet duct (17). Dust thrown up as the particulate material passes into the reactor vessel (4) is drawn along hose (16), into dust extraction duct (15) and then a separator hopper (12), which separates the dust from the transport gas.

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Method of Charging a Vessel with Particulate Material

The present invention relates to a method of charging a vessel with particulate material, and particularly to such a method for use where harmful dust may be evolved during charging.

Particulate solids are conventionally conveyed pneumatically using high velocity air or gas under negative pressure (vacuum). Such pneumatic conveying systems are used extensively in the oil, gas, chemical and petrochemical industries to charge (or load) reactor vessels with catalyst pellets.

When charging reactor vessels in this way, it is important to minimise the amount of dust evolved in the reactor vessel during charging, to reduce the risk of dispersion of dust to the atmosphere or exposure of operatives to dust. This is because the catalytic material often contains volatile and inflammable hydrocarbons, toxic elements, or residual precious metals.

An improved method of charging a reactor vessel with particulate material has now been devised which alleviates the abovementioned difficulty.

According to the invention, there is provided a method of charging a vessel with particulate material, which method comprises:

a) inducing flow of a transport gas along a flowpath extending from an upstream store of said particulate material to downstream vacuum means arranged to induce said flow such that said particulate material is drawn from said store;

b) providing separator means in said flowpath arranged to separate said particulate material and said transport gas, such that when said transport gas passes along a portion of said flowpath downstream of said separator means said gas is substantially free of said particulate material;

c) discharging from said separator means particulate material separated thereby, into said vessel, thereby charging said vessel; wherein,

d) valve means is selectively actuated to permit dust or other airborne material to be drawn from the interior of said vessel by said vacuum means whilst simultaneously substantially inhibiting said particulate material being drawn from said upstream store.

It is preferred that respective vacuum lines (typically comprising flexible hosing) are provided upstream and downstream of the separator means defining the flowpath to and from the separator means respectively.

It is preferred that a further vacuum line is provided extending, in use, from a first end disposed in the interior of the vessel to a second end communicatively connected to the vacuum line downstream of the separator means.

The further vacuum line defines a flowpath from the interior of the vessel along which the dust or other airborne material is drawn.

Preferably, the communicative connection between the further vacuum line and the vacuum line downstream of the separator means comprises respective communicating manifold members, advantageously extending transversely to one another, which comprise part of the separator means.

Typically, the valve means is provided in the further vacuum line, and actuable between an open position, in which communication between the further vacuum line and the vacuum line downstream of the separator means is permitted, and a closed position in which communication between the further vacuum line and the vacuum line downstream of the separator means is substantially inhibited. The valve means is preferably manually operable, however in certain circumstances, the valve means may be arranged to be actuated automatically, for example when a predetermined quantity of particulate material has been accumulated in the separator means.

It is preferred that the flow path downstream of the separator means is the same for both the transport gas drawn from the store and also the dust or other particulate material drawn from the interior of the vessel.

It is preferred that filter or further separator means is provided downstream of the communicative connection between the further vacuum line and the vacuum line downstream of the first-mentioned separator means, such that the dust or other airborne material drawn from the interior of the vessel may be removed from the flow before reaching the vacuum means. Advantageously, the filter or further separator means is arranged to selectively discharge the dust or other material accumulated therein into containers, which are advantageously sealingly connected to the filter or further separator means during filling.

Typically, the vessel is charged by discharging the material accumulated in the first-mentioned separator, preferably along a discharge hose, into the interior of the vessel via a manway or port provided in the uppermost region of the vessel. Advantageously, the dust or other airborne material evolved in the vessel is also drawn through a manway or port (which is preferably the same manway or port) provided in the uppermost region of the vessel.

Advantageously, actuation of the valve means causes the particulate material accumulated in the separator means to be discharged into the vessel.

It is preferred that the vacuum means comprises a vacuum pumping unit, compressor or the like.

Advantageously, the first-mentioned separator means comprises an internal structural configuration arranged to cause the transport gas passing into the separator means from the upstream vacuum line to undergo at least 180° change of direction before passing out of the separator means via the downstream vacuum line. The velocity change of the transport gas in the separator means causes the particulate material to be deposited therein. Additionally, or alternatively, conventional gas/particle filters may be used to separate the transport gas and particulate material in the separator means.

The invention will now be further described in a specific embodiment by way of example only, and with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of vacuum loading apparatus suitable for use in the method according to the invention;

Figure 2 is a schematic plan view of a part of the apparatus of Figure 1 showing flow patterns in the apparatus; and

Figure 3 is a schematic flow diagram of a vessel charging system for use in the method according to the invention.

Referring to the drawings, vacuum loading apparatus for loading a vessel (such as a reactor 4) with particulate solid material (such as catalyst 5) comprises a vacuum separator unit 1 mounted on telescopic support legs 2 so as to be positioned above the top manway 3 of a reactor vessel 4. The separator unit 1 comprises upper and lower halves 1a,1b bolted together at flange 6 to define a separation chamber 7 having a curved upper surface 8 and an inclined lower surface 9.

The separator unit 1 is provided with a catalyst inlet duct 10 for connection, by flexible conveying hose (not shown) to a catalyst store 11, the catalyst inlet duct 10 extending part way into the chamber 7. A vacuum duct 13 is communicatively connected intermediate the open ends of the catalyst inlet duct 10 and extends transversely thereto in a downward direction. The vacuum duct 13 is communicatively connected via suitable conveying hosing 13b and intermediate filter separator hopper 12, to the suction side of a vacuum unit 14.

A dust extraction duct 15 is ported to the vacuum duct 13 and connected to one end of a flexible dust extraction hose 16, the other end of which is, in use, positioned in the reactor vessel 4. A vacuum relief valve 18 is provided which is operable selectively open or close dust extraction duct 15 (alternatively, the vacuum relief valve could be provided in the vacuum duct 13 above the level of connection of dust extraction duct 15). The separator unit 1 is provided with an unloading outlet duct 17 connectable to a flexible unloading hose 17a which extends into the reactor vessel 4.

In use, the telescopic support legs 2 of the separator unit 1 are extended to position the separator unit 1 in the position shown in Figure 3 with the unloading outlet duct 17 above the open top manway 3 of reactor vessel 4. The unloading outlet duct 17 and dust extraction duct 15 are then coupled to respective flexible hoses which extend into the reactor vessel 4 through manway 3. Catalyst inlet duct 10 is connected via flexible hose to the catalyst store 11, and the vacuum duct 13 connected via vacuum hose to filter separator hopper 12 which is in turn connected via vacuum hose to the suction side of vacuum unit 14. The high pressure side of vacuum unit 14 vents to atmosphere.

Initially, vacuum relief valve 18 is closed and the vacuum unit 14 is started. The vacuum unit is used to cause a transport gas (typically air although an inert gas such as nitrogen may be used where required) to flow under negative pressure through the system. Particulate catalyst material is carried by the transport gas from the catalyst store 11, along the path shown in Figure 3, to the catalyst inlet duct 10 of the separator unit 1. The transport gas and particulate catalyst material is carried into the chamber 7 by means of duct 10 where the transport gas is forced to reverse direction (as shown in Figures 2 and 3) and pass through separator baffles 19 into the vacuum duct 13. As the gas and suspended particulate catalyst material enters the widening chamber 7 and the transport gas reverses direction, the velocity of the transport gas reduces causing the particulate catalyst material 5 to be deposited in the separator unit 1.

Some of the catalyst material 5 deposited in unit 2 passes directly under gravity along the hose extending from the unloading outlet duct into the reactor vessel 4, however the bulk of the catalyst material deposited remains in the hopper due to the vacuum back pressure caused by the transport gas passing into vacuum duct 13. In addition to the provision of velocity reducing baffles 19, a gauze filter or the like may be appropriately positioned to inhibit catalyst material being carried into the vacuum duct 13. Transport gas passes from the vacuum duct 13 along the interconnecting vacuum hose to the

filter separator hopper 12 and on to the suction side of vacuum unit 14.

In order to reduce the back pressure in chamber 7 of separator unit 1 and permit the bulk of the deposited catalyst material to exit the separator unit under gravity via unloading outlet duct 17, vacuum relief valve 18 is opened causing the gas flowpath in the system to change. Opening of vacuum relief valve 18 causes transport gas to be drawn directly through dust extraction duct 15 and not from the catalyst store 11. With valve 18 in its open position therefore, there is substantially no transport of particulate catalyst material from catalyst store 11 to the separator unit 1. Instead, transport gas drawn through dust extraction duct 15 passes directly into the vacuum duct 13 and on to filter separator hopper 12.

The free end of the hose 16 connected to dust extraction duct 15 is positioned in the interior of reactor 4. As valve 18 is opened the bulk of catalyst deposited in separator unit 1 passes under gravity from the separator unit 1 into interior of reactor 4 via the hose connected to unloading duct 17. Simultaneously, the system transport gas flow path changes as described above, and catalyst dust thrown up as the catalyst material passes into the reactor vessel 4, is drawn along hose 16 and into dust extraction duct 15. The catalyst dust then passes into vacuum duct 13 and on to filter separator hopper 12. Filter separator hopper 12 is provided with a filtration system for separating the transport gas from the catalyst dust leaving the catalyst dust deposited in the hopper 12. The filtered transport gas then passes on to the vacuum unit 14, whilst the catalyst dust is unloaded from the hopper 12 via a valve 21 into sealed collection drums 22.

When the bulk of catalyst material deposited in the separation unit 1 has been unloaded into the reactor 4, valve 18 is closed, reverting the system transport gas flowpath to that originally described, and further catalyst material is drawn from the catalyst store and deposited in the chamber 7 of separator unit 1.

The procedure described above in relation to the opening and closing of vacuum relief valve 18 is repeated until sufficient catalyst material has been deposited in reactor vessel 4 to build up the required depth of catalyst bed.

The apparatus according to the invention provides for clean, convenient and systematic deposition of catalyst material in a reactor vessel and has the significant advantage that hazardous catalyst dust evolved during deposition may be removed from the reactor vessel without being dispersed to the atmosphere.

Claims:

1. A method of charging a vessel with particulate material, which method comprises:

a) inducing flow of a transport gas along a flow path extending from an upstream store of said particulate material to downstream vacuum means arranged to induce said flow such that said particulate material is drawn from said store;

b) providing separator means in said flow path arranged to separate said particulate material and said transport gas, such that when said transport gas passes along a portion of said flow path downstream of said separator means said gas is substantially free of said particulate material;

c) discharging from said separator means particulate material separated thereby, into said vessel, thereby charging said vessel; wherein,

d) valve means is selectively actuated to permit dust or other airborne material to be drawn from the interior of said vessel by said vacuum means whilst simultaneously substantially inhibiting said particulate material being drawn from said upstream store.

2. A method according to claim 1, wherein the flow path downstream of the separator means is substantially the same for both the transport gas drawn from the store and also the dust or other particulate material drawn from the interior of the vessel.

3. A method according to claim 1 or claim 2, wherein respective vacuum lines are provided upstream and downstream of the separator means, the respective vacuum lines defining the flow path to and from the separator means.

4. A method according to claim 3, wherein a further vacuum line is provided extending, in use, from a first end disposed in the interior of the vessel to a second end communicatively connected to the vacuum line downstream of the separator means, the further vacuum line defining a flow path from the interior of the vessel along which the dust or other airborne material is drawn.

5. A method according to claim 4, wherein the valve means is provided in the further vacuum line, and actuable between an open position, in which communication between the further vacuum line and the vacuum line downstream of the separator means is permitted, and a closed position in which communication between the further vacuum line and the vacuum line downstream of the separator means is substantially inhibited.

6. A method according to claim 4 or claim 5, wherein filter or further separator means is provided downstream of the communicative connection between the further vacuum line and the vacuum line downstream of the first-mentioned separator means, such that the dust or other airborne material drawn from the interior of the vessel may be removed from the flow.

7. A method according to claim 6, wherein the dust or other material accumulated in the filter or further separator means is arranged to be selectively discharged into containers.

8. A method according to claim 7, wherein the containers are arranged to be sealingly connected to the filter or further separator means for filling with dust or other accumulated material.

9. A method according to any preceding claim, wherein the vessel is charged by discharging the material accumulated in the separator means into the interior of the vessel via a manway or port provided in the uppermost region of the vessel.

10. A method according to any preceding claim, wherein actuation of the valve means causes the particulate material accumulated in the separator means to be discharged into the vessel.

11. A method according to any preceding claim, wherein the separator means comprises an internal structural configuration arranged to cause the transport gas passing into the separator means from upstream to undergo at least 180° change of direction before passing out of the separator means.

FIGURE 1

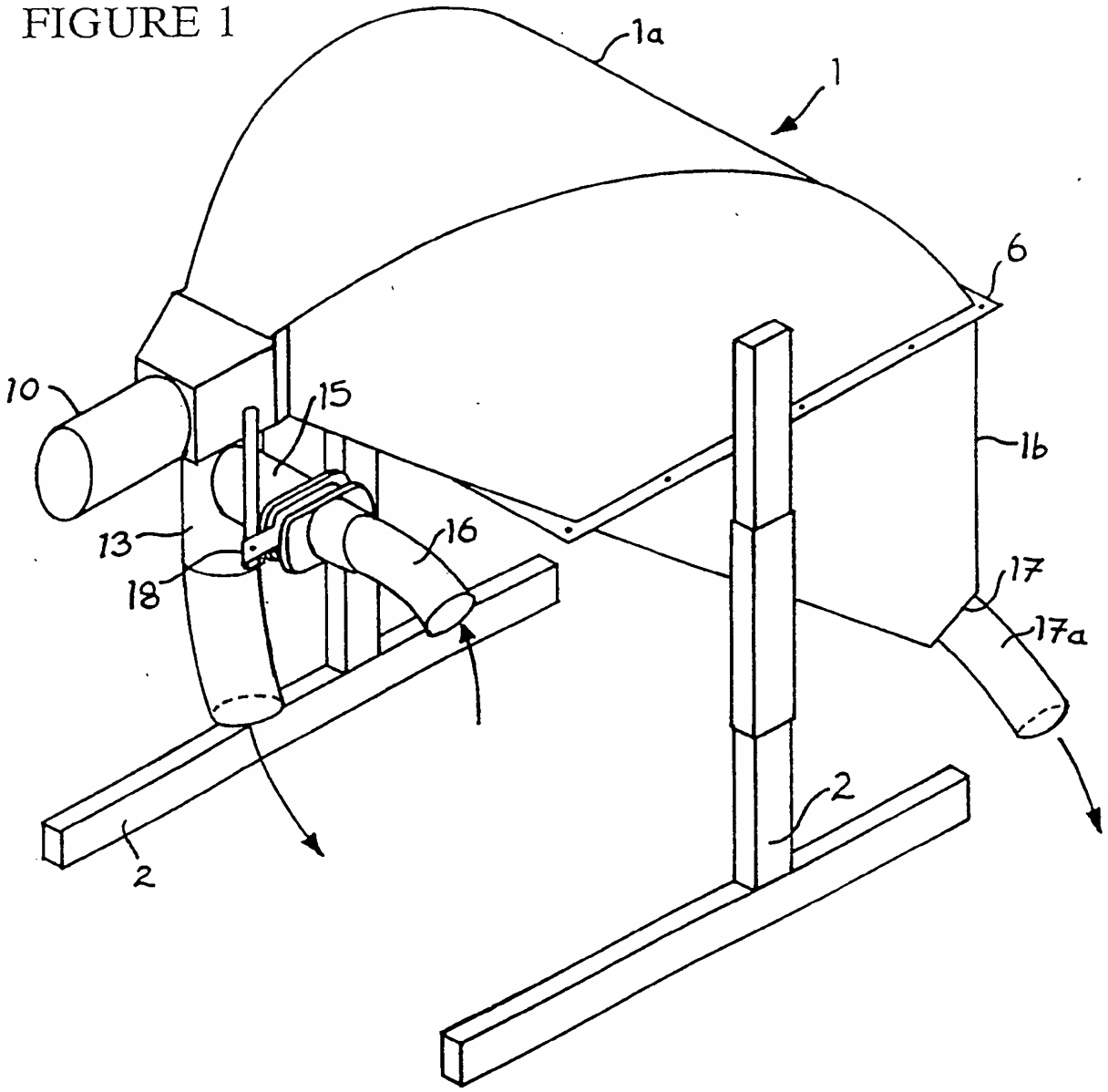
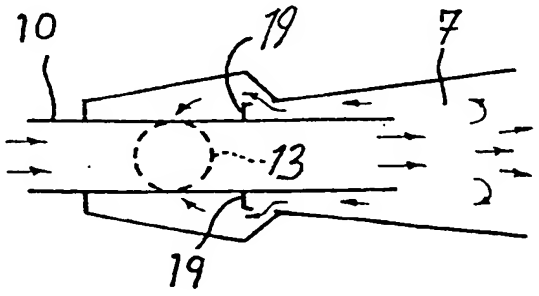


Figure 2



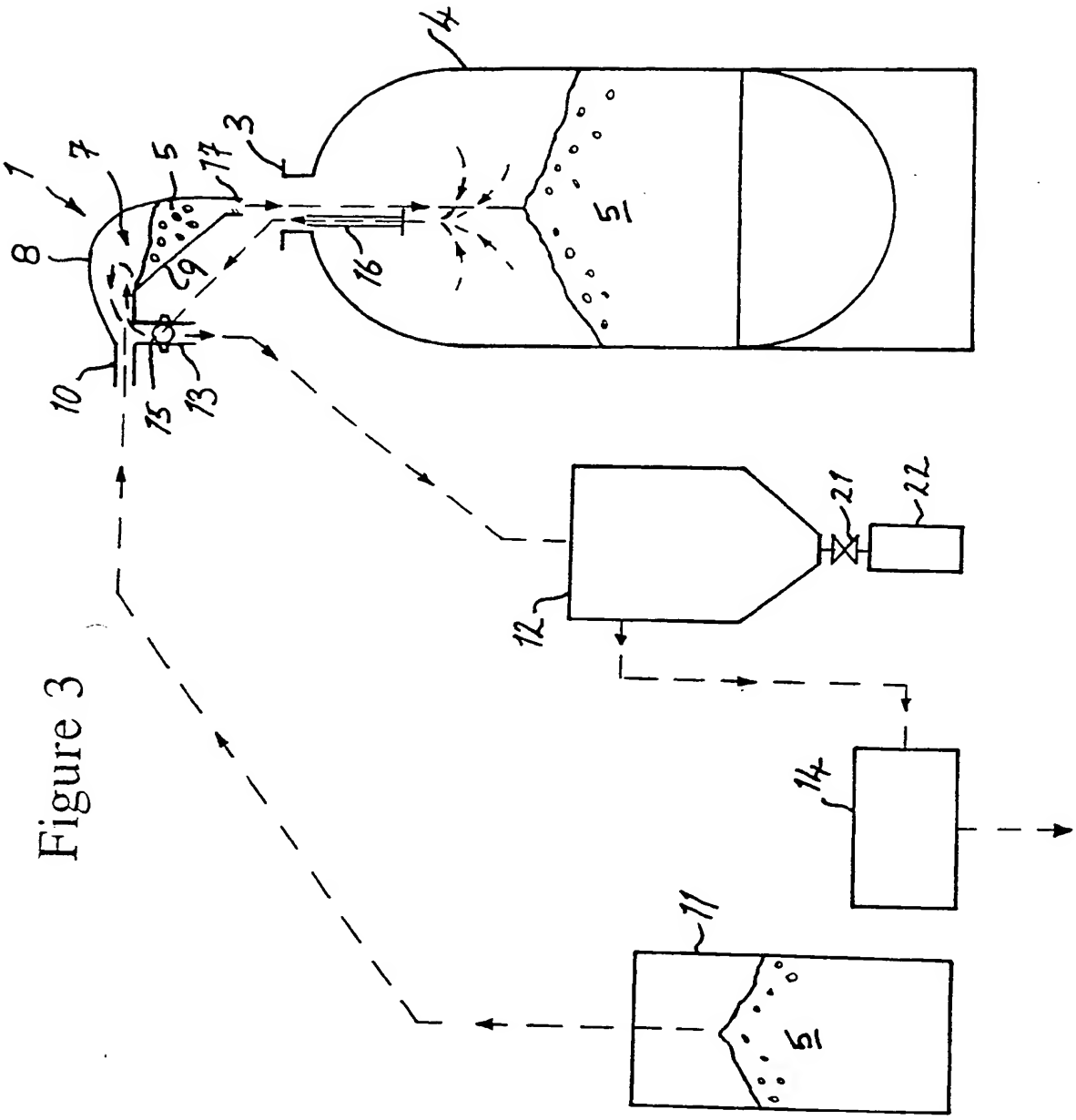


Figure 3

INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/GB 94/00800

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 B65G53/24 B65G53/60 B65G69/18 B65G53/64

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 5 B65G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE,C,595 796 (HENSCHEL & SOHN) 11 December 1930	1-4,9
A	see the whole document	10
A	WO,A,92 05858 (TECHNIVAC) 16 April 1992 see the whole document	1,11
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Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
DE-C-595796		NONE		
WO-A-9205858	16-04-92	EP-A-	0552263	28-07-93
		US-A-	5273562	28-12-93
EP-A-0305152	01-03-89	DE-A-	3873662	17-09-92
		US-A-	4892123	09-01-90